

Data Management Plan

Name of Contractor: University of Wyoming

Name of the Project: Developing a New Barrier Condition Index (BCI) to Optimize Barrier Improvements in Wyoming

Project Duration: Start Date: March 1, 2018 **End Date:** May 31, 2020

DMP Version: Final

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WYDOT Project Number: RS03218

- **Name of all peer reviewed publications, which have been generated using data from this project to include the name of the journal, volume number, date of the journal, pages numbers, DOI number and URL for the publication.**

1. The Impact of Traffic Barrier Geometric Features on Crash Frequency and Injury Severity of Non-Interstate Highways. Journal of Safety Research, Vol. 75, December 2020, Pages 155-165. <https://doi.org/10.1016/j.jsr.2020.09.005>.
2. Impact of side traffic barrier features on the severity of run-off-road crashes involving horizontal curves on non-interstate roads. International Journal of Transportation Science and Technology, In Press, Available online August 2020. <https://doi.org/10.1016/j.ijtst.2020.07.006>.
3. Estimating the effect of geometric features of side traffic barriers on crash severity of interstate roads in Wyoming. Accident Analysis & Prevention, Vol. 144, September 2020, Page.105639. <https://doi.org/10.1016/j.aap.2020.105639>.
4. Modeling the impact of various variables on severity of crashes involving traffic barriers. Journal of Transportation Safety & Security, Vol. 12, 2020 - Issue 6. January 2019, Pages 800-817. <https://doi.org/10.1080/19439962.2018.1547995>.
5. Investigating the relationship between crash severity, traffic barrier type, and vehicle type in crashes involving traffic barrier. Journal of Traffic and Transportation Engineering (English Edition), Vol. 7, Issue 1, February 2020, Pages 125-136. <https://doi.org/10.1016/j.jtte.2019.03.004>.
6. Examination of the severity of two-lane highway traffic barrier crashes using the mixed logit model. Journal of Safety Research, Vol. 70, September 2019, Pages 223-232. <https://doi.org/10.1016/j.jsr.2019.07.010>.

7. Modeling traffic barriers crash severity by considering the effect of traffic barrier dimensions. *Journal of modern transportation*, Vol. 27, April 2019, Pages 141-151. <https://doi.org/10.1007/s40534-019-0186-1>.
8. Application of Bayesian ordinal logistic model for identification of factors to traffic barrier crashes: considering roadway classification. *Transportation Letters - The International Journal of Transportation Research*, In press, published online February 2020, Pages 1-7. <https://doi.org/10.1080/19427867.2020.1728041>.
9. Two-Component Bayesian Hierarchical Models for Cost-Benefit Analysis of Traffic Barrier Crash Count. *Algorithms*, Vol. 13, Issue 8, July 2020, Page 179. <https://doi.org/10.3390/a13080179>.
10. Convolutional Neural Network for Roadside Barriers Detection: Transfer Learning versus Non-Transfer Learning. *Signals*, Vol. 2, Issue 1, February 2021, Pages 72-86. <https://doi.org/10.3390/signals2010007>.
11. Application of quantile mixed model for modeling traffic barrier crash cost. *Accident Analysis & Prevention*, Vol.148, December 2020, Page 105795. <https://doi.org/10.1016/j.aap.2020.105795>.
12. Bayesian hierarchical modelling of traffic barrier crash severity. *International Journal of Injury Control and Safety Promotion*, Vol. 28, Issue 1, November 2020, Pages 94-102. <https://doi.org/10.1080/17457300.2020.1849312>.
13. Application of Bayesian Hierarchical Negative Binomial Finite Mixture Model for Cost-Benefit Analysis of Barriers Optimization, Accounting for Severe Heterogeneity. *Algorithms*, Vol. 13, Issue 11, November 2020, Page 288. <https://doi.org/10.3390/a13110288>.
14. Application of multi-group structural equation modelling for investigation of traffic barrier crash severity. *International Journal of Injury Control and Safety Promotion*, Vol. 27, Issue 2, March 2020, Pages 232-242. <https://doi.org/10.1080/17457300.2020.1734943>.
15. A comprehensive sequential strategy for structural equation modeling of traffic barrier crashes. *Journal of Transportation Safety & Security*, In Press, Published online February 2020. <https://doi.org/10.1080/19439962.2020.1716908>.
16. Application of multinomial regression model to identify parameters impacting traffic barrier crash severity. *The Open Transportation Journal*, Vol. 13, May 2019, Pages 57-64. <http://dx.doi.org/10.2174/1874447801913010057>.

- **Dataset URL, if available:**

What constitutes data will be determined by the Principle Investigator, Project Champion, and the Research Manager. In general, your plan should address final research data. This includes recorded factual material commonly accepted in the scientific community as necessary to validate research findings. Final research data do not include laboratory notebooks, partial datasets, preliminary analyses, drafts of scientific papers, plans for future research, peer review reports, communications with colleagues, or physical objects, such as gels or laboratory

specimens. As part of your research, you may also generate unique data, which are data that cannot be readily replicated. Your DMP should also address unique data that may arise from your research.

WYDOT expects the timely release and sharing of data to be no later than the acceptance for publication of the main findings from the final dataset, unless the Principle Investigator will be embargoing the data. In such a case, the data cannot be embargoed for a period longer than 12 months. See Chapter 11 for information on retention and embargos.

1. Introduction

The purpose of this research project is to:

This study was undertaken to evaluate the impact of traffic barrier geometric factors on crash severity. Also, the study aimed to propose a methodology to provide an index that represents the overall condition of barriers and rank barriers based on benefits to be derived by enhancing barrier heights.

2. Definitions

- a. Code or scripts include code used in the collection, manipulation, processing, analysis or visualization of data, but may also include software developed for other purposes.
- b. Copyright is a set of legal rights extended to copyright owners that govern such activities as reproducing, distributing, adapting, or exhibiting original works fixed in tangible forms.
- c. Data means the recorded factual material commonly accepted in the scientific community as necessary to validate research findings, but not any of the following: preliminary analyses, drafts of scientific papers, plans for future research, peer reviews, communications with colleagues. Recorded material excludes physical objects (e.g. laboratory samples). Research data also does not include trade secrets, commercial information, materials necessary to be held confidential; and personnel and medical information and similar information the disclosure of which would constitute a clearly unwarranted invasion of personal privacy.
- d. Data Archive is a site where machine-readable materials are stored, preserved or possibly redistributed to individuals interested in the materials.
- e. Data Management Plan is a document that specifies your plans for managing your data and files for a research project.
- f. Dataset means collection of data.
- g. Metadata refers to structured data about data that helps define administrative,

technical, or structural characteristics of the digital content.

3. Data Types and Storage

The types of data and/or datasets generated and/or used in this project include ...

A field survey was conducted between the summer of 2016 through the summer of 2018 to collect data for traffic barriers on Wyoming interstate and state highway systems. The data related to geometric features and physical information collected included barrier type, system height, post-spacing, side-slope, lateral offset, shoulder width, segment width, hazard fixed-object behind traffic barriers, flare/parallel length, and bridge transition. The geometric data collected was merged with historical crash data collected from the CARE package. Data from five geometric locations of the barrier was collected. Based on the scope of this study, data collectors inventoried barriers on interstate and state highway system, in Wyoming, apart from locations that presented high safety risks to data collectors.

The data documentation will have information describing the data collection procedure, data processing, what is contained within the dataset, time of collection, persons involved in the collection, and data quality assurance processes.

The combined size of the data is expected to be a maximum of a few gigabytes. The data is not expected to change over the project period. Microsoft excel will be used to process and visualize the data. Standard software programs including R and SAS will be utilized for statistical analysis. Pre-processed data will be stored on the WYDOT data warehouse. This will create a useful backup for the collected data that will be readily accessible.

Provide a description of the data that you will be gathering in the course of your project. You should address the nature, scope, and scale of the data that will be collected. Describe the characteristics of the data, their relationship to other data, and provide sufficient detail so that reviewers will understand any disclosure risks that may apply. Discuss value of the data over the long-term. Please provide the name of all repositories where the data will be housed during the lifetime of the project.

Checklist

- What type of data will be produced?
- How will data be collected? In what formats?
- How will the data collection be documented?
- Will it be reproducible? What would happen if it got lost or became unusable later?
- How much data will it be, and at what growth rate? How often will it change?
- Are there tools or software needed to create/process/visualize the data?

- Will you use pre-existing data? From where?
- Storage and backup strategy?

4. Data Organization, Documentation, and Metadata

The plan for organizing, documenting, and using descriptive metadata to assure quality control and reproducibility of these data include ...

The data formats will be in Microsoft Excel spreadsheets and PDF files which can be readily imported by different software packages. The project number will be adopted as the format for the file naming convention. Changes to files will be tracked by appending a sequence of numbers or letters to the project number. Data will be shared by providing access to the principal investigator and other students working on the project.

Data validation will be done by applying identifiable rules that will ensure that the data is accurate. Data that does not meet minimum levels of acceptable quality will be flagged and removed from the database.

Your DMP should describe the anticipated formats that your data and related files will use. To the maximum extent practicable, and in accordance with generally accepted practices in your field, your DMP should address how you will use platform-independent and non-proprietary formats to ensure maximum utility of the data in the future. If you are unable to use platform-independent and non-proprietary formats, you should specify the standards and formats that will be used and the rationale for using those standards and formats.

NOTE: Attach the Metadata Schema, URL for data generated, and all peer reviewed publications from this project.

Checklist

- What standards will be used for documentation and metadata?
- Is there good project and data documentation format/standard?
- What directory and file naming convention will be used?
- What project and data identifiers will be assigned?
- Is there a community standard for metadata sharing/integration?

5. Data and/or Database Access and Intellectual Property

What access and ownership concerns are there...

No intellectual property issues are expected to exist with the data to be collected for this project. Wyoming highway datasets that will be collected are owned by WYDOT who will restrict personal and business details from the database. WYDOT will be responsible for allowing access to the data for processing and modification, and access restrictions. Access to the data will involve seeking authorization from WYDOT who may then allow access to a part or the whole dataset. There will be no embargo periods to uphold.

Protecting research participants and guarding against the disclosure of identities and/or confidential business information is an essential norm in scientific research. Your DMP should address these issues and outline the efforts you will take to provide informed consent statements to participants, the steps you will take to protect privacy and confidentiality prior to archiving your data, and any additional concerns. If necessary, describe any division of responsibilities for stewarding and protecting the data among Principal Investigators.

If you will not be able to deidentify the data in a manner that protects privacy and confidentiality while maintaining the utility of the dataset, you should describe the necessary restrictions on access and use. In general, in matters of human subject research, your DMP should describe how your informed consent forms will permit sharing with the research community and whether additional steps, such as an Institutional Review Board (IRB), may be used to protect privacy and confidentiality.

Checklist

- What steps will be taken to protect privacy, security, confidentiality, intellectual property or other rights?
- Does your data have any access concerns? Describe the process someone would take to access your data.
- Who controls it (e.g., PI, student, lab, University, funder)?
- Any special privacy or security requirements (e.g., personal data, high-security data)?
- Any embargo periods to uphold?

6. Data Sharing and Reuse

The data will be released for sharing in the following way ...

Property rights for the data created will be held by WYDOT. The data will be collected and stored in a manner that allows for the efficient sharing of the data with other interested parties. The data will be submitted to WYDOT after the project and may be shared through the WYDOT Data Warehouse. Interested parties will seek permission for access to the data from

WYDOT. The data will be available for access and modification using standard data and statistical software such as Microsoft Excel and R.

Describe who will hold the intellectual property rights for the data created by your project. Describe whether you will transfer those rights to a data archive, if appropriate. Identify whether any copyrights apply to the data, as might be the case when using copyrighted instruments. If you will be enforcing terms of use or a requirement for data citation through a license, indicate as much in your DMP. Describe any other legal requirements that might need to be addressed.

Checklist

- If you allow others to reuse your data, how will the data be discovered and, shared?
- Any sharing requirements (e.g., funder data sharing policy)?
- Audience for reuse? Who will use it now? Who will use it later?
- When will I publish it and where?
- Tools/software needed to work with data?

7. Data Preservation and Archiving

The data will be preserved and archived in the following ways ...

After the completion of the project, the data may be archived by WYDOT in the National Transportation Library repository as recommended by the US Department of Transportation public access plan.

Describe how you intend to archive your data and why you have chosen that particular option. You may select from a variety of options including, but not limited to:

- Use of an institutional repository.
- Use of an archive or other community-accepted data storage facility.
- Self-dissemination.

You must describe the dataset that is being archived with a minimum amount of metadata that ensures its discoverability. Whatever archive option you choose, that archive must support the capture and provision of the National Transportation Library metadata requirements. In addition, the archive you choose must support the creation and maintenance of persistent identifiers and must provide for maintenance of those identifiers throughout the preservation lifecycle of the data. Your plan should address how your archiving and preservation choices meet these requirements.

Checklist

- How will the data be archived for preservation and long-term access?

- How long should it be retained (e.g., 3-5 years, 10-20 years, permanently) ?
- What file formats? Are they long-lived?
- Are there data archives that my data is appropriate for (subject-based? Or institutional)?
- Who will maintain my data for the long-term?

NOTE:

Researchers evaluating data repositories as the option(s) for storing and preserving their data should examine evidence demonstrating that the repository:

- a. Promotes an explicit mission of digital data archiving.
- b. Ensures compliance with legal regulations, and maintains all applicable licenses covering data access and use, including, if applicable, mechanisms to protect privacy rights and maintain the confidentiality of respondents.
- c. Has a documented plan for long-term preservation of its holdings.
- d. Applies documented processes and procedures in managing data storage.
- e. Performs archiving according to explicit workflows across the data life cycle.
- f. Enables the users to discover and use the data, and refer to them in a persistent way through proper citation.
- g. Enables reuse of data, ensuring appropriate formats and application of metadata.
- h. Ensures the integrity and authenticity of the data.
- i. Is adequately funded and staffed, and has a system of governance in place to support its mission.
- j. Possesses a technical infrastructure that explicitly supports the tasks and functions described in internationally accepted archival standards like Open Archival Information System (OAIS).

NOTE: This DMP is created as a derivative from the DMP belonging to the University of Minnesota and can be found at <https://www.lib.umn.edu/datamanagement/DMP>

Metadata Schema

Elements	(remove the examples below and insert the responses to each of the elements)
Title¹	Developing a New Barrier Condition Index (BCI) to Optimize Barrier Improvements in Wyoming
Creator/contact point	<p>Khaled Ksaibati, Ph.D., P.E. ORCID ID: orcid.org/0000-0002-9241-1792 Professor Dept. of Civil & Architectural Engineering University of Wyoming Laramie, WY 82071 (307) 766-6230. khaled@uwyo.edu</p> <p>Amirarsalan Mehrara Molan, ORCID: 0000-0002-8540-1174. (417) 266-8356. amol@calpoly.edu</p> <p>Milhan Moomen, ORCID: 0000-0001-8324-7540. (765) 237-8230. mmoomen125@gmail.com</p> <p>Mohammed Mahdi Rezapour Mashhadi, ORCID: 0000-0003-0774-737. (701) 215-9523 mrezapou@uwyo.edu</p>
Publication Date(s)	May 2021
Description/Abstract	<p>Traffic barriers are installed on roadsides and medians to shield motorists from hazardous objects and other vehicles. Due to the important role played by traffic barriers in promoting safety, it is important to continuously assess their condition and performance. This study prioritized and ranked traffic barriers on Wyoming's highways for safety improvement by enhancing the height of barriers below recommended thresholds. This was achieved by conducting a benefit-cost analysis to estimate the reduction in crashes that would be gained by adjusting barrier heights. The analysis indicated that substantial benefits would be accrued if barrier heights are optimized. Traffic barriers on Wyoming's highways were then ranked based on the estimated benefits. As part of the study, a safety evaluation was carried out to identify the geometric factors of traffic barriers that impact crash severity. Finally, a condition assessment procedure referred to as the Barrier Condition Index (BCI) was used to demonstrate a new approach in the condition assessment, rating, and prioritization of traffic barriers.</p>
Subject and Keywords	Traffic Barrier, Improvement, Condition Index, Optimization, Benefits, Wyoming

¹ To include alternate title; conference title; and journal title, if they are different.

Elements	(remove the examples below and insert the responses to each of the elements)
Identifier² and/or source	<ol style="list-style-type: none"> 1. https://doi.org/10.1016/j.jsr.2020.09.005. 2. https://doi.org/10.1016/j.ijtst.2020.07.006. 3. https://doi.org/10.1016/j.aap.2020.105795. 4. https://doi.org/10.1016/j.aap.2020.105639. 5. https://doi.org/10.1080/19439962.2018.1547995. 6. https://doi.org/10.1016/j.jtte.2019.03.004. 7. https://doi.org/10.1016/j.jsr.2019.07.010. 8. https://doi.org/10.1007/s40534-019-0186-1. 9. https://doi.org/10.1080/19427867.2020.172804. 10. https://doi.org/10.3390/a13080179. 11. https://doi.org/10.3390/signals2010007. 12. https://doi.org/10.1016/j.aap.2020.105795. 13. https://doi.org/10.1080/17457300.2020.1849312. 14. https://doi.org/10.3390/a13110288. 15. https://doi.org/10.1080/17457300.2020.1734943. 16. https://doi.org/10.1080/19439962.2020.1716908. 17. https://doi.org/10.2174/1874447801913010057.
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Intellectual Property and Other Rights	This document is available through the National Transportation Library; and the Wyoming State Library. Copyright © 2018. All rights reserved, State of Wyoming, Wyoming Department of Transportation, and the University of Wyoming.
License	Microsoft Excel.

² To include record numbers; report numbers; NTIS number; TRIS Accession Number; OCLC Number; ISBN; ISSN; contract number; and DOI if available.

Elements	(remove the examples below and insert the responses to each of the elements)
Code and software needs	The data will be available for access and modification using standard data and statistical software such as Microsoft Excel and R.
Format	The data formats will be in Microsoft Excel spreadsheets and PDF files which can be readily imported by different software packages.
Choice of Repository	NA

NOTE: Each separate report, dataset, collection, existing collection, and software developed must have its own table. All fields in this Schema must be completed at the time of the final report.

NOTE: This Metadata Schema is created as a derivative from the Common Core required fields which can be found at <https://project-open-data.cio.gov/schema/>.